**Students demonstrate an understanding of processes and change over time within earth systems by …**

  2a using given data (diagrams, charts, narratives, etc.) and advances in technology to explain how scientific knowledge regarding plate tectonics has changed over time.

**What do these GSEs mean? What subtopics do students need to address to understand these GSEs?**

* Earth's Structure
  + Compositional make-up
  + Layers(3) core, mantle, crust
* Continental plates--8-
  + (North American, South American, Nazca, Eurasian, Pacific, African, Antartic, Indian-Austrailian)
* Plate Boundaries
  + Divergent—spreading center—mid-ocean ridges-convection—seafloor spreading
  + Convergent—subduction zone, trenches, island arcs, volcanoes, earthquakes, mountains
  + Transform--earthquakes
* Theories of Plate Movement--2-(convection, Gravity)
* The Rock cycle
  + igneous
  + sedimentary
  + metamorphic

**History of plate tectonics**

* Geologic time scale
* 1596—Abraham Ortelius
* 16th century-—hand line measurements of ocean depth
* 1855—1st evidence of underwater mountains
* 1914-1918—echo sounding devices—measured ocean depth
* Continental Drift Theory (Alfred Wegner--1912)
  + - Pangaea 200 MYA
      * Laurasia
      * Gondwanaland
      * Fossil evidence & Glaciatiation
* 1929—Arthur Holmes
  + Mantle—thermal convection
* 1947—ocean floor sediment thinner than thought
* 1950’s—Mid-ocean ridge discovery
* 1962--Seafloor spreading Hypothesis
  + R. Dietz & Harry Hess
    - Mid-Ocean Ridge
    - Deep Sea Trenches
    - Island Arcs
    - Geomagnetic Patterns
    - Fault Patterns

**Plate Tectonic Theory—1950’s**

* **Evidence** 
  + Ocean Floor Mapping
    - Ocean floor ruggedness and youth
  + Magnetic Striping and polar reversals
    - Evidence of past magnetic field reversals
  + Seafloor spreading back into focus/oceanic crust recycling
  + Documentation of earthquake and volcanic activity concentrated areas.

**Technological Advances for studying plate tectonics**

* The use of submarines in WW II
  + - * Echo sounding
      * Magnometers
* Post war oil demand—
  + Off shore drilling techniques used in ocean (analyzed samples)
    - Ocean floor younger near mid ocean ridge
* Space technology
* GPS
* Laser geodynamics satellites
  + LAGEOS 1, 2: LAser GEOdynamics Satellite  
    <http://msl.jpl.nasa.gov/QuickLooks/lageosQL.html>
  + LAGEOS  
    <http://www.space.com/scienceastronomy/planetearth/lageos_000418.html>
  + Satellite laser ranging   
    <http://en.wikipedia.org/wiki/Satellite_laser_ranging>

**What ideas to students need to understand before they can address the topics described above?**

* Students need to understand that scientific theories often are changed as new discoveries are made.
* The earth as we know it today has evolved over many billions of years and continues to change.
* Definitions

**What misconceptions are students likely to have about these topics?**

* Continental drift and plate tectonics--they are not the same thing.
* Edges of plates vs. edges of continents—
* The mantle is made of fluid and that the lithosphere plates float on this fluid
* Rotation of earth causes continents to move
* Continents floats on oceans
* Earthquakes form when plates crash

**What phenomena and representations help students understand these topics?**

**Geologic Time scale**

<http://paleobiology.si.edu/geotime/main/index.html>

**Good detailed labeled diagrams of the earth** <http://earthguide.ucsd.edu/eoc/eoc_teachers_hs_earth/content_tectonics/p_dia_interior.html>

**Interactive-- plates and boundaries**

<http://learner.org/interactives/dynamicearth/plate.html>

**The Rock Cycle**

<http://www.beyondbooks.com/ear82/7.asp>

**Animated gifs—Geologic time**

Last 750 million years: [[1.04 MB](http://www.ucmp.berkeley.edu/geology/anim1.html)] [[506 KB](http://www.ucmp.berkeley.edu/geology/anim2.html)] [[261 KB](http://www.ucmp.berkeley.edu/geology/anim3.html)]

Last 750 million years in reverse: [[1.04 MB](http://www.ucmp.berkeley.edu/geology/anim4.html)] [[506 KB](http://www.ucmp.berkeley.edu/geology/anim5.html)]

From 750 mya to the beginning of the Paleozoic: [[294 KB](http://www.ucmp.berkeley.edu/geology/anim6.html)] [[166 KB](http://www.ucmp.berkeley.edu/geology/anim7.html)]

From 750 mya to the beginning of the Mesozoic: [[532 KB](http://www.ucmp.berkeley.edu/geology/anim8.html)] [[284 KB](http://www.ucmp.berkeley.edu/geology/anim9.html)] [[156 KB](http://www.ucmp.berkeley.edu/geology/anim10.html)]

From the beginning of the Mesozoic to Recent: [[301 KB](http://www.ucmp.berkeley.edu/geology/anim11.html)] [[163 KB](http://www.ucmp.berkeley.edu/geology/anim12.html)] [[96 KB](http://www.ucmp.berkeley.edu/geology/anim13.html)]

**What activities or activity sequences can be used to address these GSEs?**

Concept maps

Jigsaw puzzles

Geologic Time scales